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GEORGIA POWER
A SOUTHERN COMPANY

April 29, 2014

Ms. Magalie R. Salas
Secretary, Federal Energy Regulatory Commission
888 First Street, NE Room 1-A
Washington, D.C. 20426

RE: ROBUST REDHORSE REPORT VOLUME 9
SINCLAIR HYDROELECTRIC PROJECT (FERC NO. 1951)

Dear Ms. Salas:

Please find enclosed a report entitled Conservation and Restoration of the Robust Redhorse *Moxostoma robustum*, in the Oconee River, Georgia, Volume 9, submitted in partial fulfillment of the requirements of Article 404 of the above-referenced license.

The first report, Volume 1, was submitted in 1998. Since 1998, subsequent annual reports documented increased knowledge of the species' life history and progress toward conservation throughout its historic range including creating refugial populations through stocking. Prior to the spring of 2014, recent years of drought affected stream flows as documented in studies combined with analysis of long-term monitoring data which revealed insights to drought effects on the Oconee population. Since 2011, uncertainty whether the existing flow regime in the Oconee River at Sinclair Dam is benefiting robust redhorse has been followed by the Flow Advisory Team's work to determine if altering Sinclair Project flows is warranted. The current report, Volume 9, which accompanies this cover letter, provides the current status of robust redhorse.

Volume 9 focuses on activities between February 2013 and February 2014. Volume 9, Part 1 is attached. Part 2 is incorporated into letter narrative below. Thorough discussions of past robust redhorse conservation efforts can be found in previous volumes and in the vast information maintained on the Robust Redhorse Conservation Committee (RRCC) website, www.robustredhorse.com.

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ROBUST REDHORSE REPORT VOLUME 9

Page 7 of the attached Volume 9, Part 1, stages the introduction of Volume 9, Part 2, where narrative references the Negotiated Flow Agreement which was finalized in 1995, and implemented June 1996. Volume 9, Part 2, incorporated in this letter below, describes a proposed modification to the negotiated flow agreement as steered by the Flow Advisory Team for the Oconee River.

The existing negotiated flow agreement for the Sinclair Hydroelectric project was designed primarily to enhance reproductive success of the robust redhorse by providing significant increases in minimum flows and flow stability throughout the year and run-of-river flows during spawning and early rearing periods for robust redhorse. Anadromous species also were considered during formation of the flow agreement. Prior reporting in Volume 8 indicated uncertainty as to whether the existing flow regime in the Oconee River at Sinclair Dam has benefitted robust redhorse. As an action, the Flow Advisory Team then developed a flow modification recommendation that was to be evaluated for efficacy resulting in a formal flow recommendation request before presentation to the Commission in this report (Volume 9, Part 2).

In summary, Article 401 of the Sinclair license outlines (Table 1 below) the existing operation of Sinclair Dam throughout the year as follows: (section d) restricts dam operation to "run-of-river" (ROR) during the month of May; (section e) operations to conduct the May run-of-river flows into the first 10 days of June "unless electric system requirements necessitate that the Sinclair Project be operated in NP mode (NP=normal peaking, two-turbine peaking).

Table 1. Negotiated flow agreement for the Sinclair Hydroelectric Project.

Month	Flow	Operation
December - February	500 cfs minimum	normal peaking
March - April	1500 cfs minimum	modified peaking[a]
May	run-of-river	
June[b] - November	700 cfs minimum	normal peaking

[a] modified peaking refers to the number of units (1 or 2) utilized, depending on inflow into the reservoir
[b] from June 1-10, units are operated run-of-river unless electric system demands necessitate normal peaking operation. The agreement also provides for an increase in generation (from 5 to 7 days per week) to reduce extended low-flow periods that previously resulted from little weekend generation.

Following its flow effects assessment in 2013, the Flow Advisory Team proposes the following modification to the current flow regime at Sinclair Dam – per section (e) only as follows:

e) During June through November, the Sinclair Project shall release 700-cfs minimum flow with NP with the following exception. From June 1 through ***June 15*** *the Sinclair Project shall continue the May ROR flows, unless electric system requirements necessitate that the Sinclair Project be operated in NP mode. The biological responses to the flow modification would be evaluated every three years. Management actions that could affect the future flow regime will*

result from recommendations by the Flow Advisory Team based on the observed responses in the Oconee River robust redhorse population. The modification will be implemented beginning in 2014.

In summary, Volume 9, reports that monitoring efforts for robust redhorse in the Oconee River downstream of Sinclair Dam since 2008 have not yielded observations or captures nor have sampling efforts on artificial gravel augmentation sites. The current status of the Oconee population of robust redhorse is unknown. Sampling upstream of Sinclair Dam will continue in 2014, and sampling downstream the dam will be intensified compared to previous years. The Flow Advisory Team is proposing that the Commission recognize a minor modification to the flow regime schedule (that Georgia Power Company is prepared to implement beginning in 2014) and for which biological response will be evaluated following each 3-year operational period.

An intensive springtime sampling effort to monitoring robust redhorse throughout their known range on the Oconee downstream of Sinclair dam is already underway in 2014. Survey logistics were patterned by cooperators experienced in the robust redhorse conservation effort since its beginning.

If you have any questions or comments on this report, please contact me at 404/799-2142.

Sincerely,

Anthony Dodd, CFP
Environmental Specialist
Environmental Affairs
Georgia Power Company

enclosures

ATTACHMENT

Conservation and Restoration of the Robust Redhorse (*Moxostoma robustum*) in the Oconee River, Georgia

Volume 9
Part 1

April 2014

Conservation and Restoration of the Robust Redhorse (*Moxostoma robustum*) in the Oconee River, Georgia

Volume 9

Part 1

April 2014

Prepared for the

Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

on behalf of

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Table of Contents

1. Introduction

This report is the ninth report in a series of bi-annual reports regarding the status of the robust redhorse (*Moxostoma robustum*) as required by the Federal Energy Regulatory Commission (FERC) license for Georgia Power Company's (GPC) Sinclair Hydroelectric Project (FERN No. 1951). Article 404 of the Sinclair Project license, issued by the FERC on 19 March 1996 (effective date 1 May 1996), requires the submission of a progress report to the FERC every two years, "which summarizes the status of the robust redhorse and makes a determination on the adequacy of flow releases in meeting the needs of this species."

The reporting period for Volume 8 began March 2011 and ended February 2013. This Volume 9 reporting period focuses on activities between February 2013 and February 2014. Thorough discussions of past robust redhorse conservation efforts can be found in previous volumes and in the vast information maintained on the Robust Redhorse Conservation Committee (RRCC) website, www.robustredhorse.com.

Material for this report was gathered from several sources, including project reports, status updates, RRCC updates, personal communications, and oral presentations.

1.1 Sinclair Hydroelectric Project

Sinclair Dam is a 45-megawatt GPC owned and operated hydroelectric facility, which was completed in 1952 on the Oconee River near Milledgeville, GA. The dam forms Lake Sinclair, a 15,330-acre reservoir that is a popular fishing and recreation destination in central Georgia (Figure 1). The Sinclair Project's primary function is to provide generation capacity during peak demand periods, and serve as the lower reservoir for GPC's Wallace Dam pumped storage project.

During the early stages of FERC relicensing in 1991, an assumed extinct fish species was "rediscovered" in the Oconee River downstream of the Sinclair Project. Eventually, the fish was confirmed as the robust redhorse by several ichthyologists.

Figure 1. State of Georgia showing the location of GPC's Sinclair Hydroelectric Project and major rivers within the Georgia portion of the historic range for the robust redhorse.

1.2 Robust Redhorse (*Moxostoma robustum*)

Robust redhorse was originally described in 1870 by naturalist Edward Cope from specimens collected in the Yadkin River, North Carolina. However, Cope's original specimens were lost, and labels and names were mistakenly applied to other species. For over 100 years, the robust redhorse remained unnoticed by ichthyologists until 1991. In August 1991, Georgia Department of Natural Resources (GA DNR) fisheries biologists collected five large suckers from the Oconee River downstream of Sinclair Dam. Several well-known ichthyologists including Dr. Henry Bart (then curator of the Auburn University fish collection), Dr. Byron Freeman, curator of the University of Georgia (UGA) fish collection, and Dr. Robert Jenkins of Roanoke College worked to identify the fish. The ichthyologists concluded that the five suckers were the same species originally described by Cope in 1870. In the evaluation of past collections, ichthyologists also determined that an individual collected in the Savannah River, Georgia/South Carolina in 1980 and an individual collected from the Pee Dee River, North Carolina in 1985 were in fact robust redhorse, although previously assumed to be an undescribed sucker.

With specimens confirmed in the Carolina's and Georgia, the currently accepted historic range for robust redhorse is Atlantic slope rivers with a northern extent of the Yadkin / Pee Dee River drainages in North and South Carolina down to the Altamaha River system in

Georgia (Figure 2). Following the "rediscovery" of robust redhorse, reviews of available information suggested conservation and restoration actions should commence immediately for the species. Concerns about the species' population status arose when the possibility that the Oconee fish may have represented a sole remnant population were realized. In addition, all captured fish were large, mature individuals (> 400 mm TL), and may represent a senesing population or evidence of unsuccessful recruitment. Other concerns included the effect of modified flows from power generation, erosion, siltation, and introduced predators such as flathead catfish.

Figure 2. Presumed historic range of robust redhorse (Coughlan, 2000).

1.3 Robust Redhorse Conservation Committee

The discovery of the Oconee River population led to the establishment of the Robust Redhorse Conservation Committee (RRCC), which is a multi-stakeholder partnership, which was codified under a Memorandum of Understanding (MOU) in 1995. The RRCC was designed to restore the robust redhorse throughout its currently accepted historic range by implementing research and conservation measures, enhancing recruitment in existing populations, and re-establish robust redhorse populations in appropriate river systems within the species' former range.

Through collaborative efforts and information-sharing among members and other interested parties, the RRCC has identified and prioritized potential threats to the species, conducted research related to those threats, and formulated the potential solutions through various

conservation actions. The RRCC's recovery efforts have been effectively publicized, and have been the driving force behind the conservation and restoration of robust redhorse.

Alice Lawrence of the U.S. Fish and Wildlife Service (USFWS) is currently serving as the Chair of the RRCC, and will serve in that capacity through October 2014. While some individual representatives have changed, member organizations comprising the Executive Committee (Excom) have remained the same since 2005. Those members include the GA DNR, South Carolina Department of Natural Resources (SC DNR), North Carolina Wildlife Resources Commission (NC WRC), USFWS, U.S. Geological Survey (USGS), GPC, Duke Energy, Progress Energy, representatives from academia, and others.

Memorandum of Understanding

The MOU's purpose is to establish and describe the RRCC. The first MOU was approved in 1995, and a revised version in 2005 expired at the end of 2009. The current operating version of the MOU became effective on January 1, 2010 and will expire December 31, 2015.

Robust Redhorse Conservation Strategy

The Robust Redhorse Conservation Strategy (Strategy) describes the extent of knowledge of robust redhorse and its distribution, discusses problems facing the species, and lists specific goals and objectives for robust redhorse conservation throughout its historic range. The Strategy also outlines certain procedures and actions believed necessary to reach those conservation goals and objectives. The Strategy is a flexible document, which can be revised as new information arises. No changes to the Strategy have been made since its approval in 2003.

RRCC: Policies

The RRCC policy document, as adopted on October 18, 2002, unifies protocols, practices, and activities of member organizations needed to implement the long- and short-term goals established in the Strategy. These policies provide a framework for development of individual management plans for specific robust redhorse populations. In general, the policies are organized such that consistency among goals, conservation activities, and administration at the RRCC are maintained at all levels.

1.4 Candidate Conservation Agreement with Assurances for the Robust Redhorse: Ocmulgee River, Georgia

One of the primary stated goals for the RRCC is to create additional populations of robust redhorse by introducing the species to rivers within its historic range. In many cases, reintroduction can be successfully accomplished without incident. However, the RRCC recognized the reintroduction of a rare species with potential to require future listing under

the Endangered Species Act (ESA) could be problematic. In this case, the RRCC needed a sound approach for effectively handling one of the most critical components of the conservation effort.

One approach, published by the USFWS in 1999 (64 Federal Register 32726-32736 and 50 C.F.R. §§ 13 and 17), was the use of Candidate Conservation Agreements with Assurances (CCAA). CCAAs promote conservation actions by encouraging partnerships between private entities and state and federal natural resources agencies to protect rare species with the goal of addressing potential threats to their survival. Voluntary participants in such agreements may receive assurances from the USFWS that limit risk, should the target species of that agreement become listed under the ESA.

The Ocmulgee River, a candidate site for reintroduction, provided an opportunity for applying the CCAA policy. The upper reaches of the Ocmulgee River are influenced by generation from GPC's Lloyd Shoals Dam hydroelectric facility, which has a 30-year FERC license expiring January 1, 2024. During past relicensing efforts, minimum flow was increased to enhance aquatic habitat, and a labyrinth weir was constructed to improve dissolved oxygen concentrations in the river. GA DNR, USFWS, and the RRCC determined that the 18-mile reach downstream of Lloyd Shoals Dam was suitable habitat for a proposed reintroduction. Since that time, the weir has been removed adding habitat and connectivity within the dam tailrace, and water quality has been greatly improved with the installation of passage aeration devices in penstock draft tubes.

GPC has invested considerable time and money on environmental enhancements to the upper Ocmulgee River and believed these enhancements also would benefit any potential robust redhorse population. However, GPC also believed that a reintroduction of robust redhorse potentially represented an undefined risk to the Lloyd Shoals facility, if the species was federally listed under the ESA. GPC expressed these concerns to GA DNR and the USFWS, which ultimately led to a CCAA for the robust redhorse [Candidate Conservation Agreement with Assurances for the Robust Redhorse (*Moxostoma robustum*), Ocmulgee River, Georgia, 2001].

Under the CCAA, GPC agreed to support specific conservation actions following introduction by the GA DNR, including funding for telemetry studies on the reintroduced fish, surveys, and population estimates. In return, GPC received assurances that if the robust redhorse is listed under the ESA, and the CCAA has been implemented in good faith by GPC, the USFWS will not require additional land, water, or resource restrictions beyond those that GPC voluntarily committed to under the terms of the original agreement. These assurances include the preservation of the flow regime described in the current FERC license for the Lloyd Shoals Project. The assurances are provided through an Enhancement of Survival Permit, which will take effect if and when the robust redhorse is federally listed under the ESA.

This CCAA is important as it provides additional conservation actions for the robust redhorse, while providing some regulatory certainty and operational flexibility to GPC. More importantly, the CCAA is an example of overall conservation effort providing a framework for the structure for potential reintroductions as a cooperative effort to benefit the species. It is believed that this CCAA for the robust redhorse was the second CCAA implemented in the United States, and was the first CCAA to involve an aquatic species and a private company.

1.5 Potential Listing of the Robust Redhorse

In 2010, the Center for Biological Diversity (CBD) submitted a citizen's petition to the USFWS for the listing consideration of 404 Southeastern Aquatic Species (http://www.biologicaldiversity.org/programs/biodiversity/1000_species/the_southeast_freshwater_extinction_crisis/index.html), including the robust redhorse. CBD's in-house assessment of the status of robust redhorse was largely informed by NatureServe online data, miscellaneous reports, meeting notes from the RRCC website, and earlier volumes of this report. The CBD asserted in its petition that dams, dredging/straightening, and land use have and continue to destroy suitable habitat, historical overfishing may have occurred, predation potential is likely high due to the introduction of nonnative piscivores, and state listing designations are inadequate to fully protect the species. The CBD also stated that while actions by the RRCC MOU signatories to recover the species are to be applauded, the MOU and RRCC lack the requisite regulatory protection to ensure conservation of the species. The CBD's petition also acknowledges the existence of the Ocmulgee CCAA, but discounts the ability of that agreement to provide adequate protections to the species given the continued degradation of habitat across the species range. Furthermore, the CBD petition fails to acknowledge any FERC related compliance obligations of RRCC members (such as this report and flow augmentation for robust redhorse at the Sinclair Dam) and any ongoing FERC relicensing project activities with other facilities or entities designed to accommodate and enhance robust redhorse recovery activities.

In response to this and several other petitions, the USFWS agreed to a settlement with CBD which sets a rough timetable for consideration and listing decision for the species contained in the petition. The USFWS has agreed to publish annual timelines updating activities toward listing review for these species and to prioritize their process such that those species who were already candidates would be considered first, followed by non-candidate species. Since robust redhorse was not considered a candidate species as of 2010, the USFWS will defer listing determination until at least 2016, although their information gathering process is ongoing. As a result of this petition and subsequent new listing review, the RRCC has embarked upon a major revision and update to our website which includes updating information, reports, meeting minutes and presentations. In addition, select members of the RRCC are currently preparing a status assessment of the robust redhorse, and providing documentation to support the current status of the species. The status report is expected to be completed in spring 2014. Although a work-in-progress, FERC is invited to engage the current status assessment or any of the RRCC partners for additional information and resources beyond that which is included in this report.

1.6 Flow Advisory Team for the Oconee River

The Flow Advisory Team for the Oconee River (Advisory Team) is implemented under Article 404 of Sinclair's FERC license. The current members of the Advisory Team include GA DNR, GPC, Georgia Wildlife Federation (GWF), USFWS, and USGS. The primary responsibilities of the Advisory Team are to monitor the effect of the negotiated flows for the Sinclair Project on the robust redhorse in the Oconee River. The agreement tasks the Advisory Team to review the flow data from the Oconee River, the studies developed by the RRCC, and any other pertinent information related to the robust redhorse to help determine if any changes to the negotiated flow agreement are necessary. If studies suggest that flow changes are needed for the Oconee River to improve habitat for the robust redhorse, the Advisory Team may petition the FERC, under consensus of members, with its recommendations. These recommendations would then be subject to appropriate FERC evaluation and approval.

Negotiated Flow Agreement

A negotiated flow agreement was finalized in 1995 (implemented June 1996) prior to the submittal of the FERC license application for the Sinclair Project. The negotiated flow agreement, outlined in Table 1 below, was designed primarily to enhance reproductive success of the robust redhorse. Specifically, the flow agreement provides: 1) significant increases in minimum flows throughout the year; 2) significant increase in flow stability throughout the year; and 3) run of river flows during spawning and early rearing periods for robust redhorse. Although primarily directed at robust redhorse, anadromous species also were considered during the formation of the flow agreement. The effects of this flow regime are discussed further in Part 2 of this document.

Table 1. Negotiated flow agreement for the Sinclair Hydroelectric Project.

Month	Flow	Operation
December - February	500 cfs minimum	normal peaking
March - April	1500 cfs minimum	modified peaking[a]
May	run-of-river	
June[b] - November	700 cfs minimum	normal peaking

[a] modified peaking refers to the number of units (1 or 2) utilized, depending on inflow into the reservoir

[b] from June 1-10, units are operated run-of-river unless electric system demands necessitate normal peaking operation. The agreement also provides for an increase in generation (from 5 to 7 days per week) to reduce extended low-flow periods that previously resulted from little weekend generation.

2. Current Range-wide Status of Robust Redhorse

Populations of robust redhorse currently exist in the Oconee, Ocmulgee, Ogeechee, and Broad Rivers, Georgia; in the Savannah River, Georgia and South Carolina; in the Broad and Wateree Rivers, South Carolina; and in the Yadkin/Pee Dee River drainage, North and South Carolina (Figure 3). Native populations exist in the Oconee, Savannah, and Pee Dee Rivers; whereas the remaining populations are introduced.

The current status of each population is generalized and compiled below. Because this report only includes updates between February 2013 and February 2014, information regarding the current status of each robust redhorse population has been compiled from published peer-reviewed journal articles, finalized research reports from various agencies, academic research, personal communications, as well as abstracts and status updates submitted to the RRCC for their 2013 annual meeting.

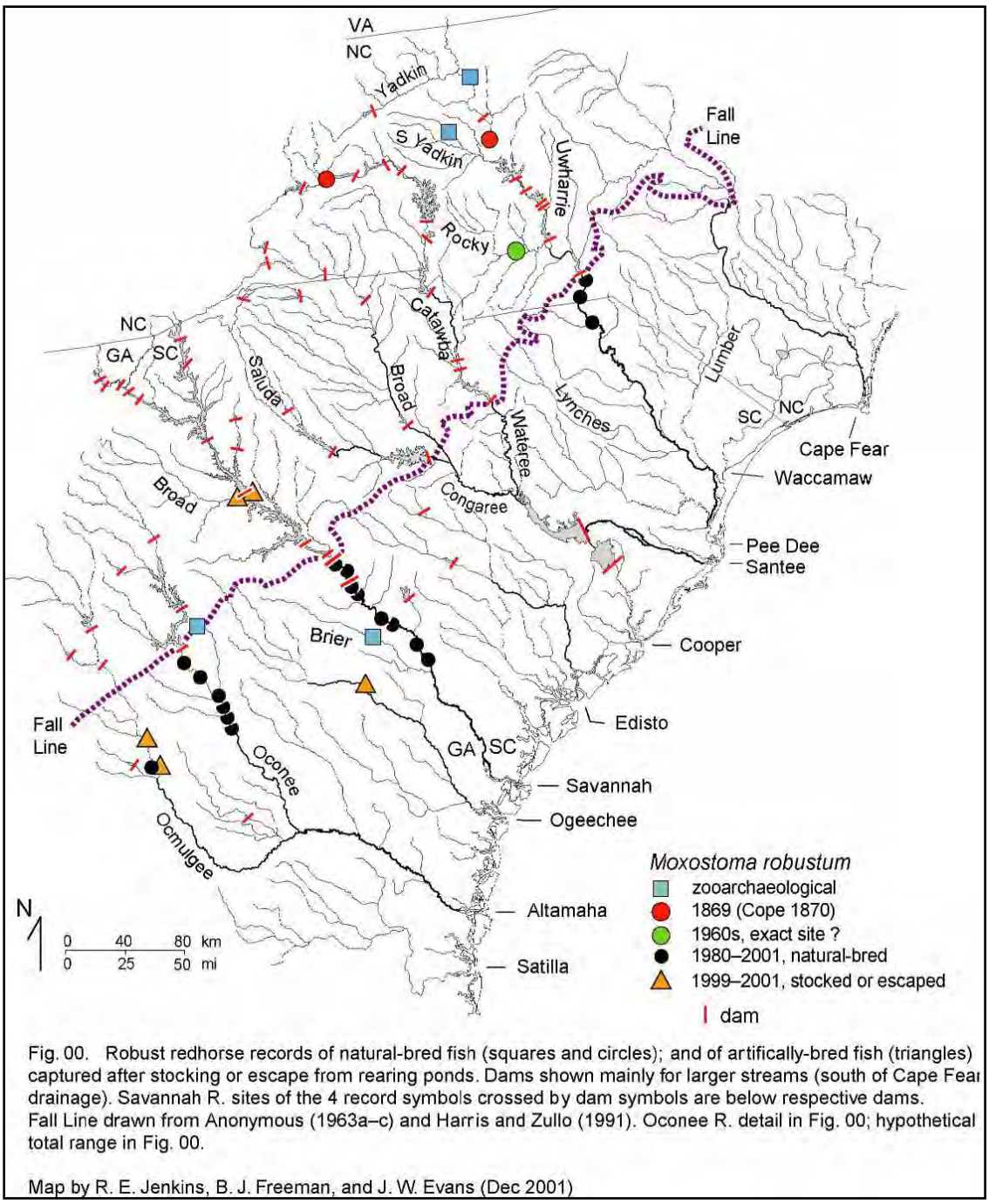

Fig. 00. Robust redhorse records of natural-bred fish (squares and circles); and of artifically-bred fish (triangles) captured after stocking or escape from rearing ponds. Dams shown mainly for larger streams (south of Cape Fear drainage). Savannah R. sites of the 4 record symbols crossed by dam symbols are below respective dams. Fall Line drawn from Anonymous (1963a–c) and Harris and Zullo (1991). Oconee R. detail in Fig. 00; hypothetical total range in Fig. 00.

Map by R. E. Jenkins, B. J. Freeman, and J. W. Evans (Dec 2001)

Figure 3. Map of the range of robust redhorse in Georgia, South Carolina, and North Carolina as of 2001.

2.1 Oconee River Population (Georgia)

The only known wild population of robust redhorse in the Oconee River system is located downstream of Sinclair Dam. In 2012, robust redhorse sampling efforts were expanded above Sinclair Dam in the Little River, Murder Creek, and the mainstem Oconee River

above Wallace Dam to determine if a remnant wild population existed (GA DNR, Summary for the 2013 RRCC annual meeting). In addition, a total of 219 robust redhorse fingerlings escaped into a small tributary to the Little River as a result of a dam failure at the Walton Fish Hatchery in 1995. This unintentional stocking may have resulted in the establishment of a small population of introduced robust redhorse in the Little River, Lake Sinclair, and/or Murder Creek.

The 2012 sampling was focused during the peak of the spawning period to determine if an adult spawning population is present in the Lake Sinclair drainage. During 2012, the Oconee River mainstem above Wallace Dam, Murder Creek, and the Little River sampled via boat electrofishing. Robust redhorse were not captured in the Oconee River or Murder Creek, however, one large, approximately 18-year old female was collected in the Little River. The condition of the mucous coating, coloration, and flaccid abdomen indicated the female was days from spawning. Although detailed habitat information in the Little River is not available, there is a possibility this fish was migrating upstream to potential spawning habitat along the Oconee National Forest towards East Glades Road (County Road 300). Although unconfirmed, the age and location of this fish suggests it was one of the numerous escapees from the Walton Fish Hatchery dam failure in 1995.

Sampling effort continued in 2013 for wild and/or stocked robust redhorse above Sinclair Dam (Little River, Murder Creek) and above Wallace Dam (Apalachee and Oconee River). After considerable effort, robust redhorse were not detected in the 2013 sampling efforts above Sinclair and Wallace Dams. Sampling in the Little River, Apalachee River, and Wallace Dam tailrace will continue in 2014. Other recovery activities planned for 2014 include intensive sampling efforts from below Sinclair Dam to Dublin, GA, and to continue to monitor the gravel augmentation sites and the historic Avant Mine spawning site for any evidence of spawning activity.

2.2 Ocmulgee River Population (Georgia)

As part of the Ocmulgee River CCAA between GPC and USFWS, the USGS Cooperative Fish and Wildlife Research Unit (GA Coop Unit) was contracted in 2010 to conduct a study in attempt to estimate adult redhorse population size within the ~18-mile reach between Lloyd Shoals Dam and Juliette Dam. Although this project was conducted during 2010 and 2011, results were finalized in December 2013 (Pruitt, 2013). To examine seasonal distribution of robust redhorse, the GA Coop Unit sampled (via boat electrofishing) all accessible reaches of river of multiple times during multiple seasons. Fish capture data was used alongside detailed habitat characteristics obtained though detailed side-scanning sonar imagery, and were integrated in occupancy models to determine robust redhorse habitat use.

Within the 18-milr subject reach, there is a 5.5-mile reach of river that was inaccessible to researchers as a result of a long series of shallow bedrock shoals. These shallow, rocky portions of the river did not allow navigation of electrofishing boats. However, the remaining

12.5 miles of river was sampled via boat electrofishing twice per season for four seasons (spring, summer, and fall 2010, and spring 2011). Throughout the course of the study, all robust redhorse detections between Lloyd Shoals Dam and Juliette Dam were located within 2,000 feet of Lloyd Shoals Dam. In spring 2010, approximately 6-8 robust redhorse were observed in a spawning aggregation in the first set of shoals immediately downstream of Lloyd Shoals Dam. The following spring (2011), an additional 8-10 adult robust redhorse in spawning condition were observed on the same set of shoals. Robust redhorse also were observed in summer 2010 in the tailrace of Lloyd Shoals Dam. Robust redhorse were not detected in reaches of the Ocmulgee River in distances greater than 0.5-mile downstream of Lloyd Shoals Dam. The limited number of captures and observations of robust redhorse may be the result of either: 1) stocked fish have traversed over Juliette Dam and are unable to reenter the project site; or 2) robust redhorse are remaining in shoal habitats year-round and are inaccessible to researchers.

Occupancy analysis revealed that robust redhorse had a high affinity for shallow, swift water near shoals, and are most likely to be present in areas containing large amount of coarse substrates like bedrock, cobble and gravel. Because robust redhorse did not appear to be present in river reaches containing large amounts of woody debris, and were found nearly exclusively in shoals, there is a possibility that robust redhorse in the project site are residing in shoals during all seasons of the year and are well-adapted for shoal habitats found in the Piedmont portion of rivers within its historic range. Prior to the robust redhorse "rediscovery," access to Piedmont habitats has been restricted through the construction dams in the past century. Restoring connectivity from the Coastal Plain to the Piedmont or stocking robust redhorse above these migration barriers may give this highly migratory fish access to suitable habitat that was once available 100 years ago. Evidence from this study shows that robust redhorse stocked from 2002-2005 have survived and are participating in spawning activities in the tailrace of Lloyd Shoals Dam, but evidence of successful recruitment has not been verified.

2.3 Ogeechee River Population (Georgia)

In attempt to establish a refugial population of robust redhorse, approximately 43,000 fingerlings from Oconee broodstock were stocked in the Ogeechee River from 1997 to 2004. The Ogeechee River was chosen as a suitable system because of its geographic isolation from other systems (thereby decreasing the probability of mixing genetically distinct populations), is presumed free of introduced predator such as flathead catfish, and is one of the few North American river systems free of major impoundments and dams.

A recent research project conducted from 2010-2012 in the Ogeechee River (Ely and Zimpfer, 2013) had three main objectives: 1) document spawning location(s) and spawning migration patterns; 2) determine if successful reproduction and recruitment are occurring; and 3) estimate the size structure and year-class strength of the population, where feasible.

Adult Robust Redhorse and Spawning

Thirty robust redhorse were captured from December 2010 – April 2011, were surgically implanted with internal radio-transmitter tags, and released at various locations in the Ogeechee River (Ely and Zimpfer, 2013). These fish were tracked and located in 2011 and 2012 to observe migrations patterns and attempt to locate spawning aggregations. During the source of the study, eight gravel bars in the project area appeared to be suitable spawning habitats for robust redhorse. These eight gravel bars were monitored for spawning activity. Spawning was only confirmed at one of those sites, where 3 tagged fish were located in an aggregation of 10-15 robust redhorse, which were observed participating in spawning activities.

Movement of stocked robust redhorse in the Ogeechee River appeared to be similar to movement observed in other populations. Upstream migrations and spawning activity was documented in 2011. This observation marks the first time spawning activities have been documented in the Ogeechee population. However, in 2012, spawning was not observed, and movement was largely restricted to deep pools and river bends as a result of severe drought in 2012. The reduced discharge and water levels during the spring and summer of 2012 appeared to be an important factor in spawning behavior and movement of robust redhorse by restricting the availability of suitable habitats for robust redhorse.

Juvenile Sampling and Recruitment

Fourteen sampling stations were established at various locations along the mainstem Ogeechee River. From July to October 2011, each site was sampled at least twice via backpack electrofisher, boat electrofishing, or seining, depending on sampling conditions. All sucker species were collected, identified and checked for tags or markings, measured, tagged (if robust redhorse) and released. No robust redhorse were captured via backpack electrofishing or seining. One adult robust redhorse was captured via boat electrofishing. Although several hundred juvenile suckers were collected during the sampling efforts, no young robust redhorse were collected. Robust redhorse stocked into the Ogeechee River have survived and are actively spawning when conditions are suitable. However, evidence for successful recruitment has not been collected (e.g., no juvenile robust redhorse have been collected). The lack of juvenile robust redhorse capture may be the result of inefficiency of sampling gear, low juvenile densities, lack of juvenile habitat, or sampling incorrect habitat. Whether the population size structure observed in this study is the result of failed recruitment or inability to detect juvenile robust redhorse is uncertain. However, current research suggests that inefficiencies in capturing juveniles may be more related to inaccessible habitats and the inability to sample appropriate environments, low juvenile densities, or fish behavior (Ely and Zimpfer, 2013).

2.4 Broad River Population (Georgia)

A report regarding the ongoing robust redhorse research including tracking movements of adult fish, the location of spawning sites, and juvenile sampling in the Broad River drainage was finalized and submitted to GA DNR in April 2013 (Straight and Freeman, 2014). Between 1995 and 1998, over 33,000 robust redhorse were stocked into the Broad River. The Broad River provides a range of habitat types and frequent shoals that may be suitable for spawning purposes, suitable water quality, relatively undeveloped surrounding land use, and major upstream dams that may influence flow or species migration.

Adult Robust Redhorse and Spawning

In 2010 and 2011, a total of 20 adult robust redhorse were captured, tagged with sonic transmitters, and released. Movements of tagged adults were monitored with receivers placed throughout the Broad River and Clarkes Hill Reservoir. In general, adult fish spent the winter months within Clarkes Hill Reservoir. Each spring, the tagged robust redhorse began upstream migrations (some travel distances >62 river miles) into the Broad River to spawn. From 2007-2012, six distinct robust redhorse spawning grounds were identified in the Broad River drainage; four in the Broad River mainstem, one in the Hudson River, and one as far north as the North Fork of the Broad, as confirmed through visual surveys.

Juvenile Sampling and Recruitment

To look for evidence of recruitment, juvenile sampling surveys took place in 2009 and 2011. Young-of-year (YOY) fish for several sucker species were captured in the Broad River, but no robust redhorse YOY were collected. At present, no wild-spawned YOY robust redhorse have been collected in any waters throughout its range. The lack of YOY captures for robust redhorse may be contributed to sampling incorrect habitat types, using ineffective sampling gear, or reduced larval survival.

Assuming robust redhorse maturity is reached in 5-6 years and the first groups of stocked robust redhorse have successfully reproduced, the first generation of wild-spawned fish should be reaching maturity (and consequently arriving to spring spawning grounds where capture is most likely) in 2003-2008, with a possible second generation around 2008-2013. Because only 20 adult robust redhorse were captured during the course of the 2010-2011 (for tracking purposes), population estimates could not be obtained. However, visual observations on active spawning sites revealed that stocked hatchery fish survived to spawning age, are actively participating in spawning events, and the spawning populations is estimated to range from 86-107 or greater. Continued sampling of spawning grounds in coming years should reveal if wild-spawned fish have survived and been assimilated into the active spawning population.

2.5 Savannah, Broad, and Wateree River Populations (South Carolina)

In recent years, South Carolina's efforts have focused on establishing self–sustaining populations of robust redhorse in the Santee River Basin by stocking individuals from Savannah River broodstock (SC DNR, Final Report for the SC State Wildlife Grant, 2013). The Savannah River population has been monitored though the 10 years of brood stock collection at a spawning bar located below the Savannah Bluff Lock and Dam. To date, a total of 271 robust redhorse have been collected in the Savannah River, and the population below the lock and dam appear to be one of the most stable and healthy natural populations.

Through the 2013 grow-out and stocking season, nearly 72,000 juveniles from 98 individual matings of Savannah broodfish have been stocked into the Santee River Basin (Broad and Wateree Rivers). Robust redhorse were stocked into the Broad and Wateree Rivers each year from 2004-2009. No fish were stocked from 2010-2012, but stocking efforts resumed in 2013 with 5,941 Phase I (6-month old), 25 Phase III (30-month old), and 20 Phase IV (42-month old) fish into the Broad and Wateree Rivers. Over the years, stocking has been successful, and fish have matured and repeatedly have been observed to exhibit spawning behavior.

Electrofishing, sonic telemetry, and visual surveys resulted in the confirmation of adult fish in spawning condition within the Wateree and the Broad River. Migrating robust redhorse have been documented moving upstream in the Congaree River, through the Columbia Fishway (62 fish observed ascending the fish passage in 2013), into the Broad River, and upstream to the tailrace of Parr Dam, where spawning activity has been observed (SC DNR Final Report for the SC State Wildlife Grant, 2013). Spawning activity has also been confirmed in the Wateree Dam tailrace (Steve Lamprecht, SC DNR, personal communication). The flow within the tailraces of the aforementioned dams creates suitable spawning substrate for robust redhorse. In addition, the hypolimnetic release from the dam on Murray Lake (Saluda River) lowers the summer temperatures in the mainstem Congaree River below Columbia, thus providing a cool summer temperatures for summer refuge. Although natural reproduction has not been confirmed, the condition of the wild and stocked populations of robust redhorse with the Savannah River and the Santee River Basin (Broad and Wateree Rivers) appear secure.

SC DNR has developed a standardized suite of genetic markers by multiplexing microsatellites and archiving genetic information from tissues collected from robust redhorse range-wide (SC DNR, Final Report for the South Carolina State Wildlife Grant, 2012). These genetic markers can be identified by taking a tissue sample (fin clips) of all captured robust redhorse, and will allow for offspring identification of future recaptures within the Santee River during re-establishment efforts. As genotyping of Santee River offspring progresses, genetic characterization of the new population can be assessed and compared to the Pee Dee and Savannah River populations. Essentially, genetic microsatellites will be able to distinguish wild-spawned robust redhorse from stocked hatchery fish.

2.6 Yadkin/Pee Dee River Population (North Carolina)

Pee Dee River below Blewett Falls Dam

In anticipation of the 2013 licensing, the Yadkin-Pee Dee River Technical Working Group (TWG), which includes NC WRC and Duke Energy, arranged a flow agreement providing increased minimum flows below Blewett Falls Dam on the Pee Dee River. Beginning in 2009, Duke Energy (formerly Progress Energy) has provided a minimum flow of 1,200 cfs at Blewett Falls Dam from April 15 through May 15. Starting April 15, 2011, a minimum flow of 1,200 cfs has been maintained all year. Beginning in 2012, a springtime minimum flow (February 1 – May 30) of 2,400 cfs was maintained. The minimum flow ensures that spawning areas and newly hatched larvae are not dewatered during non-generation periods. Although flows do not drop below this threshold, water levels can be much higher during power generation and flood events.

Population level monitoring in the Pee Dee ceased during the modification of the flow agreement for Blewett Falls Dam, but resumed in spring 2013 (Ryan Heise, NC WRC, Yadkin/Pee Dee River TWG Abstract for the 2013 RRCC annual meeting). During the spring 2013 sampling events (April 19-May 17), 9 individual robust redhorse were collected, 7 of which were recaptures. The two untagged fish were relatively small males, which are rarely collected in the Pee Dee River. Based on size, the two younger fish may be from the 2009 year class where the 1,200 cfs minimum flow was initially provided, and are now part of the adult spawning population. As sampling continues in subsequent years, an understanding how the new minimum flows below Blewett Fall Dam influence robust redhorse recruitment may become evident.

In spring 2013, a pilot project commenced, where fertilized robust redhorse eggs were brought to the NC WRC McKinney Lake Fish Hatchery to experiment with different culturing techniques. This pilot study was in preparation for a long-term stocking program which will begin in spring 2014, where fish will be stocked in the Pee Dee River, potentially above Blewett Falls Dam and below Tillary Dam.

Pee Dee River below Tillary Dam, above Blewett Fall Dam

Currently, a known population of robust redhorse does not occur above Blewett Falls Dam. To determine if suitable habitat exists in the Pee Dee River between Tillary Dam and Blewett Falls Dam and the feasibility of re-introduction, a habitat modeling study was completed by Fisk et al. (2014). The current FERC license for Tillary Dam requires a minimum flow of around 40 cfs, but flows are voluntarily maintained around 70-90 cfs during periods of no power generation. The proposed flows associated with relicensing are approximately 330 cfs throughout the year and 725 cfs for spawning flows during April and May (targeted for American shad). Modeled spawning suitability for robust redhorse in the reach below Tillary Dam is greatest between 3,500 and 7,000 cfs. Although robust redhorse may not have

optimal spawning conditions at the proposed flows for the new relicensing, the proposed flows may increase habitat and perform a critical function in preventing gravel bars (spawning areas) from dewatering during the spawning season over current operations.

The river reach below Tillary Dam is suitable for robust redhorse introduction, and provides access to habitats that are not present to the existing population below Blewett Falls Dam (Fisk et al., 2014). Reintroducing fish above these dams, which regulate flow and prevent migration, may benefit this rare species by expanding its range, allowing access to previously inaccessible habitats, protecting genetic diversity, and acting as buffer to catastrophic events.

3. Status of the Oconee River Population through February 2014

Since its rediscovery in 1991, the Oconee River robust redhorse population has been sampled extensively. In general, sampling strategies have been diverse in nature and technique, and have targeted various life stages and numerous habitat types within the system. However, the most rigorous sampling efforts have targeted adult robust redhorse in the spring, either during spawning migrations, or on known spawning aggregations. Other sampling surveys have been conducted in potential spawning locations (i.e., locations where suitable gravel substrate and current velocities are present), non-spawning habitats (outside bends, meanders, and deep pools with moderate flows and woody debris), and in various other habitats where surrogate species studies and laboratory experimentation suggests the species might reside. With these studies, numerous datasets have been developed, and results from those data have been highly variable.

Long-term and relatively consistent datasets regarding the adult population status have been obtained through broodfish collection for propagation activities and exploratory monitoring surveys designed to identify additional spawning aggregations. Although targeted collections at known spawning sites were highly productive at the onset of species monitoring, collections of adult robust redhorse at those sites has steadily declined over time. Sampling effort and intensity has been reduced greatly in the past decade, resulting in few robust redhorse detections in recent years, thus obtaining an accurate population estimate has not been possible.

Early population estimates ranged from 400-600 adults, and the most recent estimates show a decrease to less than 100 adults (Jimmy Evans and Brent Hess, GA DNR and Joey Slaughter, GPC, unpublished sampling and modeling data). Causes of this decline are unclear, but several hypotheses may explain the reduction in catch rates. The first hypothesis is that the adult robust redhorse population originally sampled in abundance in the early 1990's was senescing, and the combination of mortality of adults and recruitment of juveniles was slow or nonexistent caused the decline. A second hypothesis is sampling effort has been reduced and has been confined to areas where broodfish have been collected in the past, rather than the population's entire range.

Another potential cause of the reduced captures of robust redhorse is the result of the Oconee River population being oversampled or harassed to local extirpation from known spawning grounds. Essentially, this hypothesis suggests adult robust redhorse captured on known spawning aggregations have either been collected and relocated to other drainages, or have been repeatedly sampled and handled during the collection of broodstock, which in turn has caused the population to relocate to unknown spawning sites or points where large-scale spawning activities are no longer supported. Another hypothesis includes the shifts in preferred locations as result of to changes in flow (including changes in flow regime related to drought) and subsequent changes to in-stream habitat. The Oconee population was relatively stable prior to the flow change and has declined since the implementation of the current Sinclair Dam flow regime in 1995. These flow conditions may have led to the apparent decline in spawning aggregate abundance at known sites. Flathead catfish abundances within the Altamaha Basin also have steadily increased since their discovery in the system in 1970's. Although flathead catfish predation on robust redhorse has not been documented, the increase in flathead presence increases predation potential above and beyond that of the native predator community. Any or all of these factors, coupled with numerous years of excessive drought, may have ultimately led to the noted decline in adult robust redhorse collections at known spawning sites.

Although targeting broodfish/spawning adult provides useful information regarding robust redhorse, the data may be biased toward actively spawning adults or fish moving onto spawning bars. Those targeted collections might also be misleading if changes in flow alters or degrades the condition of known spawning sites over time. Changes in flow and discharge may also result in missed spawning cues. Further spawning site collections may not incorporate suitable effort, gear, or location for collecting non-spawning adults or young fish. To best understand the status of the population in its entirety, the correct combination of gear type(s), sampling location(s), and seasonality must be achieved. To that end, data during monitoring and exploratory surveys has been collected and analyzed with relatively consistent/standardize methods (i.e., electrofishing gear and techniques). Although sampling effort has declined over the years, data is collected during the spring of each year to address the current status of the population, provide context for future management, and insight on enhancing the monitoring program, and create a long-term database from which causation of the population's apparent decline can be addressed.

Current Status

The Oconee TWG proposed to place emphasis on the following objectives or tasks in 2014:

- Intensive sampling effort to assess status of the Oconee River population from Sinclair Dam to Dublin (60-80 hours total effort).
- Continuing visual, electrofishing, and hydro-acoustic monitoring of the Oconee River gravel augmentations sites and Avant Mine spawning site.
- Search for wild and/or stocked populations above Sinclair Dam in the Little River, the Wallace Dam tailrace, and the Apalachee River.

Unfortunately, robust redhorse have not been collected or observed in the Oconee River downstream of Sinclair Dam since 2008 despite continued efforts through the spring of 2013. Additionally, the visual, audible, and electrofishing effort added at artificial gravel augmentation sites have not yielded any robust redhorse. Although sampling effort has curtailed in recent years compared to the late 1990's and early 2000's, sufficient effort in the appropriate timeframe, during adequate flow regimes has been exerted to confirm the presence and population makeup of the Oconee River robust redhorse. The current status of the Oconee population is unknown, but sampling above Sinclair Dam will continue in 2014, and sampling below the dam will be intensified compared to previous years.

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